



UNITED STATES
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BUREAU OF MINES
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INFORMATION CIRCULAR

NONMETALLIC MINERALS NEEDED FOR NATIONAL DEFENSE:

3. NITRATES



BY

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NONMETALLIC MINERALS NEEDED FOR NATIONAL DEFENSE: 3. NITRATES ^{1/}

By Alvin H. Schallis ^{2/}

As nitrogen is one of the principal constituents both of fertilizers and most commercial and military explosives and as an important part of the Nations supplies of nitrogen compounds hitherto have been imported, chemical nitrogen^{3/} is a vital factor in the national defense program. Reports showing estimated industrial capacity, sources, and utilization of this element **already have been prepared by several agencies.**^{4/} The purpose of this circular, therefore, is to summarize briefly the sources and utilization of chemical nitrogen in the United States.

SOURCES OF CHEMICAL NITROGEN

There are three primary sources of chemical nitrogen for this country: (1) Imports from foreign nations, (2) fixation of atmospheric nitrogen by synthesis of ammonia, and (3) byproducts of the coke-manufacturing industry. Table 1, which reveals the sources of chemical nitrogen consumed in the United States from 1936 through 1939, shows that recently nearly half the chemical nitrogen used in this country has been produced synthetically, about one-third imported, and the remainder obtained as a byproduct of the manufacture of coke.

- ^{1/} The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 717C."
- ^{2/} Assistant mineral economist, Nonmetal Economics Division, Bureau of Mines.
- ^{3/} In this report, the term "chemical nitrogen" is used to denote all chemically combined nitrogen other than that derived directly from organic matter, either animal or vegetable.
- ^{4/} Synthetic Nitrogen Products Corporation, Report on Supplies and Disposition of Nitrogenous Fertilizer Materials in U. S. A., Fertilizer Year 1939-40: December 1940.
Fertilizer Review, Nitrogen Industry Ready for National Defense: Vol. 15, No. 5, October-November 1940, p. 12.
Zaneth, J. E., Is Chemical Industry Ready? Nitrogen Sufficiency: Ind. Eng. Chem., vol. 32, 1940, pp. 1170-1171.

TABLE 1. - Sources of chemical nitrogen for the United States, 1936-39

	1936	1937	1938	1939
Imports:				
Gross weight, short tons ^{1/}	1,034,537	1,190,090	1,133,653	1,174,892
Nitrogen content: ^{2/}				
Short tons	182,600	204,200	196,400	202,000
Percent of total United States supply	33.73	32.79	33.93	32.28
Domestic production:				
Synthetic:				
Gross weight, short tons ^{3/}	257,500	314,700	331,500	340,700
Nitrogen content				
Short tons	211,800	258,900	272,700	280,300
Percent of total United States supply	39.12	50.54	47.11	44.79
Byproduct:				
Gross weight, short tons ^{4/}	694,341	753,216	518,383	676,802
Nitrogen content:				
Short tons	147,000	159,600	109,800	143,500
Percent of total United States supply	27.15	16.67	18.96	22.93
Apparent new supply:				
Gross weight, short tons	1,986,400	2,258,000	1,983,500	2,192,400
Nitrogen content, short tons	541,400	622,700	578,900	625,800

1/ Compiled from records of the Bureau of Foreign and Domestic Commerce.

2/ Based upon estimated average nitrogen content of the various compounds as imported.

3/ In terms of NH_3 (since this is the primary form in which all synthetic chemical nitrogen is produced in this country).

4/ Bureau of Mines data; ammonium sulfate equivalent of all forms.

DOMESTIC PRODUCTION AND CAPACITY OF CHEMICAL NITROGEN

"Air" Nitrogen. - In 1939 the production of "air" nitrogen in the United States was about 280,000 tons of fixed nitrogen. The installed capacity was about 380,000 tons a year. This would indicate that in 1939 (the latest year for which accurate figures are available) plants operated at about 74 percent of capacity. Capacity probably could be increased to 410,000 tons a year by substantial modernization or alteration of existing equipment without constructing new plants. Three synthetic ammonia plants (including the rehabilitation of United States Nitrate Plant No. 2 at Muscle Shoals), with a projected capacity of about 190,000 tons annually, are under construction. When this program of expansion is completed, the combined productive capacity of synthetic chemical nitrogen plants will be about 600,000 tons a year.

Byproduct Nitrogen Output. - The production of byproduct chemical nitrogen ordinarily depends largely on the output of coke, which in turn depends largely on the production of iron and steel rather than on the demand for nitrogen. When the substantial additions being made to the capacity of byproduct-coke-oven plants are completed, the maximum increase of production of byproduct nitrogen over the 1939 level of about 140,000 tons annually will be about 50,000 tons, which will provide a maximum annual capacity of about 190,000 tons of byproduct nitrogen.

It is estimated therefore that the total potential capacity in the United States for production of both synthetic and byproduct nitrogen soon will reach 800,000 short tons a year compared with a production of 424,000 tons in 1939.

IMPORTS OF CHEMICAL NITROGEN

Imports of chemical nitrogen have amounted to about one-third of the total apparent domestic supply and comprise various products from different sources. Table 2, which shows the distribution of imports of chemical nitrogen into the United States, indicates that the chief chemical-nitrogen product imported into this country is sodium nitrate, which comes from Chile. Other chemical-nitrogen products entering this country in relatively large volume are, in the order of importance, calcium cyanamide, ammonium sulfate, ammonium nitrate fertilizer mixtures, and sodium-potassium nitrate. These five materials comprise more than 92 percent of the chemical nitrogen imported into this country. The chief source of imports of chemical nitrogen is Chile, although appreciable quantities come from Canada. These two countries together have furnished more than 85 percent of the chemical nitrogen imported into the United States. Other countries from which large quantities of chemical nitrogen have been imported are Norway, the Netherlands, and Germany, in the order named.

DISTRIBUTION OF CONSUMPTION

Exports. - Table 3, which shows the distribution of chemical nitrogen products in the United States in 1937, indicates that in that year only about 6 1/2 percent of the total domestic supply of chemical nitrogen was exported, the remainder being consumed within this country. These exports have been distributed rather widely among the various nations of the world; however, relatively large quantities go to Canada, the Philippine Islands, and the Netherland Indies.

Domestic Consumption. - The domestic utilization of chemical nitrogen may be classified as follows: (1) In fertilizers, (2) in industry (other than explosives), and (3) in explosives. In 1937 (see table 3) almost three-fourths of the total domestic supply of chemical nitrogen was consumed in fertilizers, and more than one-third of the remainder was employed in the manufacture of explosives (largely commercial). Since 1937, and especially during 1940, the use of chemical nitrogen in the manufacture of explosives has increased substantially, although the ratio of nitrogen consumed in fertilizer to that used in industry other than for the manufacture of explosives has varied only slightly.

TABLE 2. - Imports of chemical nitrogen into the United States

Material	Year	Gross weight				Nitrogen content	
		Quantity (short tons)	Percent from--			Average percent	Percentage of U.S. total imports
			Chile	Canada	Europe 1/		
Sodium nitrate.....	1919	456,354	96.1	3.7	0.2	15.5	79.1
	1929	1,049,000	99.1	-	.9	15.5	70.2
	1937	701,785	99.9	-	-	16.0	55.0
	1939	676,917	100.0	-	-	16.0	53.6
	2/1940	713,107	100.0	-	-	16.0	68.2
Calcium cyanamide.....	1919	69,575	-	90.1	9.9	20	16.4
	1929	216,000	-	100.0	-	20	19.6
	1937	138,227	-	99.6	.4	21	14.2
	1939	148,622	-	100.0	-	21	15.4
	2/1940	124,311	-	100.0	-	21	15.6
Ammonium sulfate.....	1919	2,637	-	62.7	37.3	20.6	.6
	1929	21,200	-	31.2	68.8	20.6	1.9
	1937	93,396	-	33.2	66.8	20.6	9.4
	1939	122,632	-	66.0	34.0	20.6	12.6
	2/1940	46,676	-	97.0	3.0	20.6	5.8
Ammonium- nitrate- fertilizer mixtures.....	1919	255	-	3/	3/	16	.1
	1929	22,980	-	.1	99.9	16	2.8
	1937	74,390	-	-	100.0	20.0	7.3
	1939	75,015	-	.2	99.8	20.0	7.4
	2/1940	-	-	-	-	-	-
Sodium- potassium nitrate	1919	18,826	78.8	-	21.2	14	2.9
	1929	14,340	92.6	-	7.4	14	.9
	1937	61,271	100.0	-	-	14	4.2
	1939	55,164	100.0	-	-	14	3.8
	2/1940	46,166	100.0	-	-	14	3.9
Other nitrogen compounds.....	1919	4,316	-	42.4	57.6	19.6	.9
	1929	71,840	-	28.4	71.6	16.4	4.6
	1937	121,021	-	25.2	74.8	16.7	9.9
	1939	96,542	-	27.4	72.6	16.4	7.2
	2/1940	70,714	-	73.5	26.5	15.3	6.5
Total imports	1919	551,963	4/78.3	4/18.5	4/3.2	-	100.0
	1929	1,395,360	4/70.4	4/19.3	4/10.3	-	100.0
	1937	1,190,090	4/59.2	4/19.8	4/21.0	-	100.0
	1939	1,174,892	4/57.4	4/26.9	4/15.7	-	100.0
	2/1940	1,000,974	4/72.1	4/26.0	4/1.9	-	100.0

1/ Imports from Japan are included with items from Europe but were negligible in all years except 1937 when they aggregated 1.7 percent of total imports into the United States.

2/ 11 months.

3/ Data not available.

4/ Percentage of total nitrogen content of imports.

Table 3 analyzes sources and uses of the various chemical-nitrogen materials, listing them in the order of their relative importance as sources of nitrogen. Column 4 gives the quantity of nitrogen consumed in the form of the specified commodities, expressed as percentages of the aggregate domestic consumption of nitrogen. The totals at the bottom of the table involve approximations, and these account for the minor discrepancies that exist in the data on total imports, as compared with table 1; however, these discrepancies do not affect the relative rank of the specified items.

CONCLUSIONS

The greater part of the chemical-nitrogen industry of this country at present depends on ammonia as a raw material. When the synthetic ammonia plants now under construction are completed, adequate capacity should be available to make the country independent of imports of chemical nitrogen. Meanwhile, a considerable part of normal domestic requirements of chemical nitrogen will have to be supplied by imports. Even when the full capacity of planned synthetic nitrogen plants becomes available, imports may be needed in event of a national emergency.

Most commercial nitrogen compounds may be produced either directly or indirectly from ammonia. The sodium nitrate now consumed in industry and in the manufacture of explosives is derived from ammonia because of the greater purity of the synthetic product. The only large use for Chilean nitrate is in fertilizers, for which even the impurities therein are beneficial. In short, the situation has changed considerably since 1914 when all countries, except perhaps Germany, depended on Chile for nitrogen consumed in industry as well as agriculture.

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TABLE 3. - Distribution of chemical nitrogen products in the United States, 1937

Material	Supply			(4) Total U.S. consumption	Apparent domestic consumption	
	(1) Domestic production	(2) Imports	(3) Exports		(5) Used for fertilizer	(6) Used in industry (other than explosives)
	Percent	Percent	Percent	Percent	Percent	Percent
Sodium nitrate 1/.....	2/ 39.8	60.2	11.8	27.2	80.9	13.7
Ammonium sulfate	88.4	11.6	10.6	24.8	Largely	None
Ammonia 3/.....	100.0	.0	2.0	14.7	55.0	None
Imported nitrogenous fertilizer having no domestic production 4/.	.0	100.0	.0	10.2	Largely	None
Ammonium nitrate 5/.....	2/ 61.8	38.2	.0	7.1	51.8	46.3
Nitric acid 6/.....	5/100.0	.0	.0	2/6.5	1.5	39.3
Ammonium phosphates	64.7	35.3	.0	2.4	100.0	None
Urea 7/.....	90.3	9.7	.0	2.2	Largely	None
Cyanides	47.7	52.3	1.9	1.5	None	None
Nitric oxide	100.0	.0	.0	1.4	None	None
Ammonium chloride	83.3	16.7	.0	1.0	None	None
Sodium nitrite	Largely	Little	.0	.5	None	None
Potassium nitrate	Small	Largely	Little	.4	Largely	Little
Ammonium carbonates	Largely	Little	Little	.03	None	None
Miscellaneous ammonium compounds	Largely	Little	Little	.07	Largely	None
Total.....	65.3	1/34.7	6.47	100.0	73.8	9.6

1/ Sodium nitrate used in the manufacture of nitric acid was deducted from the total imports. 2/ Estimated.
 3/ Includes that used in nitrogen solutions and in urea-ammonium liquor, but does not include that used
 in manufacture of nitrates, nitrogen oxides, or ammonium compounds. 4/ Includes calcium cyanamide from
 Canada. 5/ Includes that used in the manufacture of nitrous oxide and in the production of nitrogen
 solutions. 6/ Does not include that used in the manufacture of sodium or ammonium nitrates, but in-
 cludes that used in the nitration of organic compounds. 7/ Includes that used in urea-ammonium liquor.